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Response under 37 C.F.R. 1.116

Applicant: Robin Alexis Takasugi et al.

Serial No.: 10/672,975

Filed: September 26, 2003

Docket No.: 10014268-1 / H303.154 101

Title: PREFETCH CONTROLLER FOR CONTROLLING RETRIEVAL OF DATA FROM A DATA STORAGE DEVICE

REMARKS

The following remarks are made in response to the Final Office Action mailed August 9, 2006. In that Office Action, the Examiner rejected claims 1-30 under 35 U.S.C. §102(b) as being anticipated by Hicken et al., U.S. Patent No. 6,092,149 ("Hicken").

With this Response, Applicant respectfully traverses the Examiner's rejection of claims 1-30. Claims 1-30 remain pending in the application and are presented for reconsideration and allowance.

Reply to Examiner's Response to Remarks

In the Response to Remarks section of the Final Office Action, the Examiner stated that:

Applicant's remarks have been fully and carefully considered, with the Examiner's response set forth below.

(1). Applicants contend that the prior art (Hicken et al., US 6,092,149) does not teach or suggest "adding a prefetch value to a transfer length value specified in the current host command" because "the prefetch in Hicken et al. is a separate transfer that is determined and performed after the requested data is retrieved," thus Hicken et al. do not add a prefetch value to a transfer length value specified in the current host command, and then provide this sum to a data storage device, as recited in claim 1. The Examiner disagrees with this assessment for the following reasons.

First, the invention of Hicken et al., is directed toward using prefetched data into a cache memory to maximize disk drive performance based on past access history [abstract]. Particularly, the data prefetched in previous read commands is a factor in determining the type of access [figure 1G illustrates several types of access, including "full cache hit," "partial cache hit," "skip ahead cache hit," "sequential cache hit" and "no cache hit," column 9, lines 28-67] and the amount of data to be prefetched for the current read command. For instance, if the data prefetched in previous read commands (the prefetched data is stored in the cache buffer [figure 1A, 10]) already includes portion of the data that is requested by the current read command, then the amount of data to be prefetched for the current read command needs to be adjusted accordingly [the caching system may prescan the cache memory during prefetch to alter the prefetch amount in response to a command request (abstract); figures 8A-8E shows the details of adjusting the prefetch amount]. (Office Action at para. no. 3, pages 2-3) (emphasis in original).

Independent claim 1 recites "a transfer length generator configured to provide a first transfer length value to the data storage device if the new sequential read indication is

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generated for the current host command, thereby requesting data specified by the current host command and prefetch data, and provide a second transfer length value to the data storage device if the new sequential read indication is not generated for the current host command", and "wherein the first transfer length value is determined by adding a prefetch value to a transfer length value specified in the current host command." None of the Examiner's above citations to Hicken teaches or suggests adding a prefetch value to a transfer length value specified in a current non-sequential read command, and then providing this sum to a data storage device, thereby requesting data specified by the current host command and prefetch data.

The Examiner next stated in the Response to Remarks section that:

Second, when Hicken et al. mention that "For every read command the invention determines how much data to prefetch after the requested data is retrieved (column 10, lines 62-67)," it means determining the amount of data to be prefetched for the current read command after the requested data of the previous read command is retrieved.

This if (sic) illustrated in more details in figures 10B-10F. In figure 10B, step 725 determines if this is a "read" command, if it is a "read" command, step B2 follows. In figure 10C, step B2, step 754 determines if this is a "partial hit in prefetch and prefetch from previous command will fetch a higher LBA than the current command." If the answer is "YES," the prefetch length is adjusted to accommodate data already requested, as stated in step 756.

Third, when Hicken et al. mention that "For every read command the invention determines how much data to prefetch after the requested data is retrieved (column 10, lines 62-67)," it merely means that determining the amount of data to be prefetched for the current read command after the requested data of the previous read command is retrieved. It by no means suggests that the prefetch in Hicken et al. is a separate transfer that is performed after the requested data is retrieved, as Applicants speculate.

In fact, the requested data and prefetch data are retrieved from the disk drive [figure 1, 40] at the same time rather than separately. This is illustrated in figure 1C. In figure 1C, Step 104 determines if there is a command from the host to be processed. Step 126 computes the prefetch length, followed by Step 132, which set buffer counter (to inform the disk and to monitor how much data to be transferred from the disk for this transfer operation) and start the disk (instruct the disk to begin transfer data). Note that in the entire flowchart only one step, Step 132, involves data transferring from the disk. Thus, all data transfer from the disk to the cache buffer is performed only once, not twice for requested data and prefetch data separately. (Office Action at para. no. 3, pages 3-4) (emphasis in original).

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Again, none of the Examiner's above citations to Hicken teaches or suggests adding a prefetch value to a transfer length value specified in a current non-sequential read command, and then providing this sum to a data storage device, thereby requesting data specified by the current host command and prefetch data.

The Examiner contends above that the prefetch operation disclosed in Hicken is not a separate transfer, and cites Figure 1C as the only basis for this contention. Figure 1C of Hicken is a high level flow diagram that shows a method of processing commands from a host. As is typical with such high level diagrams, the various blocks in the diagram are represented in additional detail in later Figures, and involve multiple steps or operations. The conclusion that "all data transfer from the disk to the cache buffer is performed only once", which is based solely on the fact that only one step in this single high level diagram mentions data transferring from the disk, ignores conventional patent drafting practice, and is simply inconsistent with the more detailed disclosure provided in Hicken, as addressed below.

Hicken discloses that the disk side programs "are responsible to implement the prefetch". (Hicken at col. 19, lines 66-67; See also Hicken at col. 9, lines 66-67). The disk side programs are separate and distinct from the cache management software functions, which have been cited by the Examiner. (See, e.g., Hicken at col. 7, lines 18-26). Throughout the Hicken patent, the prefetch is referred to as a separate operation that can be completed or aborted, that has its own routines and state variables, and that is performed "after" or "following" a READ command, and "after the requested data is retrieved." (See, e.g., Hicken at col. 9, lines 66-67; col. 10, lines 62-67; col. 14, lines 20-23 and 54; col. 16, lines 49-54; col. 19, lines 66-67; col. 20, lines 28-33 and 50-54; col. 24, lines 22-24 and 49-53; col. 25, lines 53-62; col. 26, lines 57-59; col. 41, lines 11-14; and col. 42, lines 34-41 and 48-49). Hicken discloses that "[f]or every read command the invention determines how much data to prefetch after the requested data is retrieved." (Hicken at col. 10, lines 62-67) (emphasis added). "Hicken discloses that "[w]hen read caching is enabled, the disk drive 9 may perform a prefetch following any read operation in which the media 40 was accessed." (Hicken at col. 41, lines 11-14) (emphasis added). Hicken discloses "Minimum prefetch: This field indicates the lower limit on the number of blocks to prefetch after a READ or

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READ EXTENDED command Any other value indicates the number of blocks prefetched following a read operation". (Hicken at col. 42, lines 34-41) (emphasis added). Hicken discloses "Maximum prefetch: This field indicates an upper limit on the number of blocks to prefetch after a READ or READ EXTENDED command." (Hicken at col. 42, lines 48-49) (emphasis added). Hicken discloses with respect to Figure 16A that:

The method starts by receiving a first command in step 1126. The invention is in hyper mode at this stage of processing. The invention then processes the first command and only caches requested data from the disk with no prefetch in step 1128. The process then receives a second command in step 1130, which is assumed to be a random command, and processes the second command in step 1132. In step 1134, a determination is made as to whether or not the second command is sequential with the first command. If the second command is sequential with the first command, the process flows to step 1136 to cache prefetch data from the second command and identifies the second command as sequential. (Hicken at col. 37, lines 33-44).

As the above disclosure and Figure 16A clearly indicate, the prefetch at 1136 is performed after the second command (i.e., current command) is processed at 1132. All of the above disclosures in Hicken indicate that the prefetch is a separate operation. Nonetheless, it is not Applicant's burden to prove whether the prefetch is a separate operation or not. It is the Examiner's burden to establish that Hicken teaches or suggests each and every limitation of the claims. None of the Examiner's above citations to Hicken teaches or suggests adding a prefetch value to a transfer length value specified in a current non-sequential read command, and then providing this sum to a data storage device, thereby requesting data specified by the current host command and prefetch data.

The Examiner next stated in the Response to Remarks section that:

(2). Applicants also contend that the Examiner does not provide any citation to Hicken et al. to support the limitation of "the transfer length is the sum of the length of the requested data and the length of the prefetch data." The Examiner disagrees with this assessment for the following reason.

The Examiner cited in the previous Office Action figure 1f, which shows the requested data and the prefetched data being present in the same cache entry. Note that figure 1D further illustrates this point by showing that each cache entry (a cache entry is created each time a stream of data is transferred from the disk into the cache buffer) contains not only the LBA (Logical Block Address of the requested data), but also the PF LBA (PreFetch data Logical Block Address). In other words, each data stream from the disk

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drive to the cache buffer contains both requested data and prefetch data, thus the transfer length of the data stream is the sum of the length of the requested data and the length of prefetch data. (Office Action at para. no. 3, page 4).

Applicant could find no disclosure in Figures 1D or 1F or their corresponding descriptions, nor anywhere else in Hicken, that teaches or suggests adding a prefetch value to a transfer length value specified in a current read command, and then providing this sum to a data storage device. These Figures simply show how data is stored in the cache **after** it has been retrieved. The Examiner stated above that the "transfer length of the data stream is the sum of the length of the requested data and the length of prefetch data". The Examiner has not identified any disclosure in Hicken that teaches or suggests that the length of the requested data and the length of the prefetch data are actually summed or added. The Examiner has not identified any structure in Hicken that performs such an addition. The Examiner has not identified any disclosure in Hicken that teaches or suggests that such a sum is provided to a data storage device.

In addition, as with the previous Office Action, the Examiner again did not appear to address the language "thereby requesting data specified by the current host command and prefetch data" in claim 1. "All words in a claim must be considered in judging the patentability of that claim against the prior art." *In re Wilson*, 424 F.2d 1382, 1385, 165 USPQ 494, 496 (CCPA 1970). The Examiner has not identified any disclosure in Hicken that teaches or suggests simultaneously requesting data specified by a host command and prefetch data. Hicken does not teach or suggest adding a prefetch value to a transfer length value specified in a current non-sequential read command, and then providing this sum to a data storage device, thereby requesting data specified by the current host command and prefetch data.

The Examiner's specific rejections are addressed in further detail below.

35 U.S.C. §103 Rejections

The Examiner rejected claims 1-30 under 35 U.S.C. §102(b) as being anticipated by Hicken et al., U.S. Patent No. 6,092,149 ("Hicken").

Independent claim 1 recites "a sequential read detector configured to generate a new sequential read indication for the current host command if the current host command and a

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previously received host command specify read operations that are non-sequential", "a transfer length generator configured to provide a first transfer length value to the data storage device if the new sequential read indication is generated for the current host command, thereby requesting data specified by the current host command and prefetch data, and provide a second transfer length value to the data storage device if the new sequential read indication is not generated for the current host command", and "wherein the first transfer length value is determined by adding a prefetch value to a transfer length value specified in the current host command." Hicken does not teach or suggest adding a prefetch value to a transfer length value specified in a current non-sequential read command, and then providing this sum to a data storage device, thereby requesting data specified by the current host command and prefetch data.

With respect to independent claim 1, the Examiner stated that:

Hicken et al. disclose . . . a transfer length generator [For every read command the invention determines how much data to prefetch after the requested data is retrieved (column 10, lines 62-67); the transferred data comprises the "requested data" and the "prefetched data" as shown in figure 1F, and the transfer length value is the sum of the length of the requested data and the length of the prefetched data] . . . and wherein the first transfer length value is determined by adding a prefetch value to a transfer length value specified in the current host command [For every read command the invention determines how much data to prefetch after the requested data is retrieved (column 10, lines 62-67); the transferred data comprises the "requested data" and the "prefetched data" as shown in figure 1F, and the transfer length value is the sum of the length of the requested data and the length of the prefetched data]. (Final Office Action at para. no. 5, pages 5-7) (emphasis in original).

As the Examiner indicated above, Hicken discloses "[f]or every read command the invention determines how much data to prefetch after the requested data is retrieved." (Hicken at col. 10, lines 62-63) (emphasis added). Thus, the prefetch in Hicken is a separate transfer that is determined and performed "after" the requested data is retrieved. As Applicant addressed above in the Reply to Examiner's Response to Remarks, the fact that the prefetch in Hicken is a separate transfer is supported by numerous disclosures throughout the Hicken patent. Hicken does not add a prefetch value to a transfer length value specified in a

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current read command, and then provide this sum to a data storage device, as recited in claim 1.

The Examiner stated above that "the transfer length value is the sum of the length of the requested data and the length of the prefetched data". Applicant could find no disclosure in Figure 1F or its corresponding description, nor anywhere else in Hicken, that teaches or suggests adding a prefetch value to a transfer length value specified in a current read command, and then providing this sum to a data storage device.

In addition, the Examiner did not appear to address the language "thereby requesting data specified by the current host command and prefetch data" in claim 1. As discussed above, the prefetch in Hicken is a separate transfer that is determined and performed "after" the requested data is retrieved. Hicken does not teach or suggest adding a prefetch value to a transfer length value specified in a current non-sequential read command, and then providing this sum to a data storage device, thereby requesting data specified by the current host command and prefetch data, as recited in claim 1.

In view of the above, independent claim 1 is not taught or suggested by Hicken. Applicant respectfully requests removal of the rejection of claim 1 under 35 U.S.C. §102(b), and requests allowance of this claim. Since dependent claims 2-11 further define patentably distinct claim 1, claims 2-11 are believed to be allowable over the cited prior art. Applicant respectfully requests removal of the rejection of claims 2-11 under 35 U.S.C. §102(b), and requests allowance of these claims.

Claims 2-11 are also further distinguishable over the cited reference. For example, dependent claim 9 is dependent on claim 1, and recites "wherein the transfer length generator comprises: a first register for storing the prefetch value; a second register for storing a zero value; and a multiplexer coupled to the first and the second registers, the multiplexer responsive to the new sequential read indication for selectively outputting the prefetch value or the zero value." With respect to claim 9, the Examiner stated that "note that the min and max prefetch represents two registers specifying the prefetch values". (Final Office Action at para. no. 5, page 12). The min and max prefetch are numbers, or values, not registers. In addition, Hicken does not teach or suggest "a multiplexer coupled to the first and the second registers, the multiplexer responsive to the new sequential read indication for selectively

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outputting the prefetch value or the zero value", as recited in claim 9. Hicken does not appear to even mention a multiplexer.

Dependent claim 10 recites "the prefetch controller of claim 9, wherein the transfer length generator further comprises: a third register for storing the transfer length value specified in the current host command." Dependent claim 11 recites "the prefetch controller of claim 10, wherein the transfer length generator further comprises: an adder for adding the value stored in the third register and the value output by the multiplexer." The Examiner has not identified any structure in Hicken that corresponds to, or performs the functions of, the adder recited in claim 11. The Examiner has not identified any structure in Hicken that adds the transfer length value specified in a current host command to a prefetch value that has been selected and output by a multiplexer.

Independent claim 12 recites "adding a prefetch length value to the first transfer length value if the current read command and the previous read command are non-sequential, thereby generating a second transfer length value; and outputting the second transfer length value to the data storage device." As described above with respect to claim 1, there is no teaching or suggestion in Hicken regarding adding a prefetch value to a transfer length value specified in a current non-sequential read command, and then providing this sum to a data storage device. For the reasons set forth above with respect to claim 1, Hicken does not teach or suggest the above-quoted limitations of claim 12.

In view of the above, independent claim 12 is not taught or suggested by Hicken. Applicant respectfully requests removal of the rejection of claim 12 under 35 U.S.C. §102(b), and requests allowance of this claim. Since dependent claims 13-16 further define patentably distinct claim 12, and are further distinguishable over the cited reference, claims 13-16 are believed to be allowable over the cited prior art. Applicant respectfully requests removal of the rejection of claims 13-16 under 35 U.S.C. §102(b), and requests allowance of these claims.

Independent claim 17 recites "transfer length generation means for adding a prefetch length value to a transfer length value specified in the current host command if the current host command specifies a non-sequential read operation, the transfer length generation means

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configured to output a sum of the prefetch length value and the transfer length value to the storage means." As described above with respect to claim 1, there is no teaching or suggestion in Hicken regarding adding a prefetch value to a transfer length value specified in a current non-sequential read command, and then providing this sum to a data storage device. For the reasons set forth above with respect to claim 1, Hicken does not teach or suggest the above-quoted limitations of claim 17.

In view of the above, independent claim 17 is not taught or suggested by Hicken. Applicant respectfully requests removal of the rejection of claim 17 under 35 U.S.C. §102(b), and requests allowance of this claim. Since dependent claims 18 and 19 further define patentably distinct claim 17, claims 18 and 19 are believed to be allowable over the cited prior art. Applicant respectfully requests removal of the rejection of claims 18 and 19 under 35 U.S.C. §102(b), and requests allowance of these claims.

Claims 18 and 19 are also further distinguishable over the cited references. For example, claim 19 recites "the memory device of claim 17, wherein the transfer length generation means comprises: first register means for storing the prefetch length value; second register means for storing a zero value; multiplexing means for selectively outputting the prefetch length value or the zero value based on an output of the sequential read detection means; and adding means for adding an output of the multiplexing means and the transfer length value specified in the current host command." Hicken does not teach or suggest "multiplexing means for selectively outputting the prefetch length value or the zero value based on an output of the sequential read detection means", as recited in claim 19. Hicken does not appear to even mention multiplexing or a multiplexer. The Examiner also has not identified any structure in Hicken that corresponds to, or performs the functions of, the adding means recited in claim 19. The Examiner has not identified any structure in Hicken that adds the transfer length value specified in a current host command to a prefetch value or zero value that has been output by a multiplexer.

Independent claim 20 recites "generating a new sequential read indication for the current host command if the current host command and a previously received host command specify read operations that are non-sequential; outputting a first transfer length value to the data storage device if the new sequential read indication is generated for the current host

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command, wherein the first transfer length value is determined by adding a prefetch value to a transfer length value specified in the current host command; and outputting a second transfer length value to the data storage device if the new sequential read indication is not generated for the current host command, the second transfer length value less than the first transfer length value.” As described above with respect to claim 1, there is no teaching or suggestion in Hicken regarding adding a prefetch value to a transfer length value specified in a current non-sequential read command, and then providing this sum to a data storage device. For the reasons set forth above with respect to claim 1, Hicken does not teach or suggest the above-quoted limitations of claim 20.

In view of the above, independent claim 20 is not taught or suggested by Hicken. Applicant respectfully requests removal of the rejection of claim 20 under 35 U.S.C. §102(b), and requests allowance of this claim. Since dependent claims 21-30 further define patentably distinct claim 20, claims 21-30 are believed to be allowable over the cited prior art. Applicant respectfully requests removal of the rejection of claims 21-30 under 35 U.S.C. §102(b), and requests allowance of these claims.

Claims 21-30 are also further distinguishable over the cited reference. Dependent claim 28 recites “the computer-readable medium of claim 20, wherein the method further comprises: storing a prefetch value; storing a zero value; and selectively outputting the prefetch value or the zero value based on whether the new sequential read indication is generated for the current host command.” There is no teaching or suggestion in Hicken regarding selectively outputting a prefetch value or a zero value based on whether a new sequential read indication is generated for the current host command.

Dependent claim 29 recites “the computer-readable medium of claim 28, wherein the method further comprises: storing a transfer length value specified in the current host command.” Dependent claim 30 recites “the computer-readable medium of claim 29, wherein the method further comprises: adding the stored transfer length value and the selectively output value.” The Examiner has not identified any structure in Hicken that adds the transfer length value specified in a current host command to a selectively output prefetch value or zero value.

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CONCLUSION

In view of the above, Applicant respectfully submits that pending claims 1-30 are in form for allowance and are not taught or suggested by the cited references. Therefore, reconsideration and withdrawal of the rejections and allowance of claims 1-30 is respectfully requested.

No fees are required under 37 C.F.R. 1.16(h)(i). However, if such fees are required, the Patent Office is hereby authorized to charge Deposit Account No. 08-2025.

The Examiner is invited to contact the Applicant's representative at the below-listed telephone numbers to facilitate prosecution of this application.

Any inquiry regarding this Response should be directed to Jeff A. Holmen at Telephone No. (612) 573-0178, Facsimile No. (612) 573-2005. In addition, all correspondence should continue to be directed to the following address:

IP Administration
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Respectfully submitted,

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CERTIFICATE UNDER 37 C.F.R. 1.8:

The undersigned hereby certifies that this paper or papers, as described herein, are being transmitted via facsimile to Facsimile No. (571) 273-8300 on this 5th day of October, 2006.

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